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DRY BAYOU – THOMPSON BEND

U.S. ARMY CORPS OF ENGINEERS
ST. LOUIS DISTRICT
HYDROLOGIC AND HYDRAULICS BRANCH
1222 SPRUCE STREET
ST. LOUIS, MISSOURI 63103

DRY BAYOU – THOMPSON BEND REPORT

By
Matthew Rector, P.E.
Robert J. Rapp, P.E.
Michael T. Rodgers, P.E.
David C. Gordon, P.E.

U.S. Army Corps of Engineers
St. Louis District
Hydrologic and Hydraulics Branch
1222 Spruce Street
St. Louis, MO 63103

Prepared for:

U.S. Army Corps of Engineers, St. Louis District

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EXECUTIVE SUMMARY

Beginning in 1980 the St. Louis District Corps of Engineers, local land owners, and other organizations teamed together in an effort to prevent a cut off from occurring across the neck of the Dry Bayou – Thompson Bend peninsula along the Mississippi River. The creation of a riparian buffer at key locations along with management plans and some other repairs were implemented in an effort to force the Mississippi River to maintain its current course. The continuation of this project has proven to be successful, validating the idea of a riparian corridor does work to control over bank scour and river cutoffs.

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PURPOSE

The purpose of this report is to provide a historical reference for the ongoing efforts in the Dry Bayou – Thompson Bend area. This report will outline the importance of the area, problems that are being addressed with the program, and the efforts that have been undertaken. The report will also look at lessons learned throughout the efforts implemented over the course of the project life. This report will include data from the initial report published in September 1984 as well as the two appendices published in May 1985 and February 1986.

PROJECT AREA

The project area is located on the right bank of the Mississippi River between River Mile (RM) 4.0 upstream of the confluence with the Ohio River at Cairo, to RM 24.0 (See Plate 1). Along this reach, the Mississippi River flows in a broad, sweeping reverse curve. The distance is 20 river miles; the average gradient is approximately ½ foot per mile. The Mississippi River and Tributaries (MR&T) levee is aligned such that it approximately parallels the river from RM 30 to RM 21.4. At this point, which is the beginning of the large meander loop, the levee diverges from the river, leaving a 10,000-acre peninsula between the levee and the river. The narrowest distance across the neck of the large meander loop is just 1 ¼ miles. The confluence of the Mississippi and Ohio Rivers is between three and four miles downstream from where the levee and riverbank diverge. Given the close proximity of the confluence, flooding across this area is incredibly erratic. The River can run virtually backward – a high Ohio River backing up a low Mississippi, or it can be viciously swift – a high Mississippi rushing to a low Ohio. With a 14-16 foot gradient across the narrow neck of alluvial floodplain, massive erosion and scour could potentially destroy thousands of acres of valuable farmland, create a disastrous bendway cutoff, and erode a section of the Commerce/Birds Point Mainline Federal MR&T Levee. The potential results would be destruction of farmland, stopping of river transport north of Cairo for decades by the new, shorter, steep, high velocity channel and resultant channel changes upstream and downstream. The erosion of the Mainline Levee would allow the flooding of approximately 5,700 square miles of land, all the way to Helena, Arkansas, rendering over 300,000 people homeless. It is, therefore, in the best interest of local entities and the federal government to protect this critical area.

Primary access to points between the river and MR&T levee is provided by ramps and appurtenant roads. Two ramps and short road beds furnish access to Bunge and Cargill grain elevators at approximate RM 28.8 and RM 28.4, respectively, shown in Plate 1. Two other ramps and an appurtenant road system furnish access to agricultural lands across and in the vicinity of the 10,000-acre peninsula.

TIMELINE FOR THE PROJECT

In 1980, the St. Louis District teamed up with local entities and organizations to explore methods to prevent a cutoff from occurring on the Peninsula. In September of 1984 the initial report was completed. A follow up report was completed in 1985. This follow up was included with the original report as Appendix I. A second follow up was released in 1986 and titled Appendix II. Many of the recommendations and efforts listed in these projects were implemented and continued until the floods of 1993, 1994 and 1995. Following these floods, it became apparent that the Corps must take a more active role in the project. Subsequently, the Corps began purchasing land easements in the project area to facilitate the planting of vegetation and tree screens. Aerial photographs outlining a portion of the history of the site are included at the end of the report.

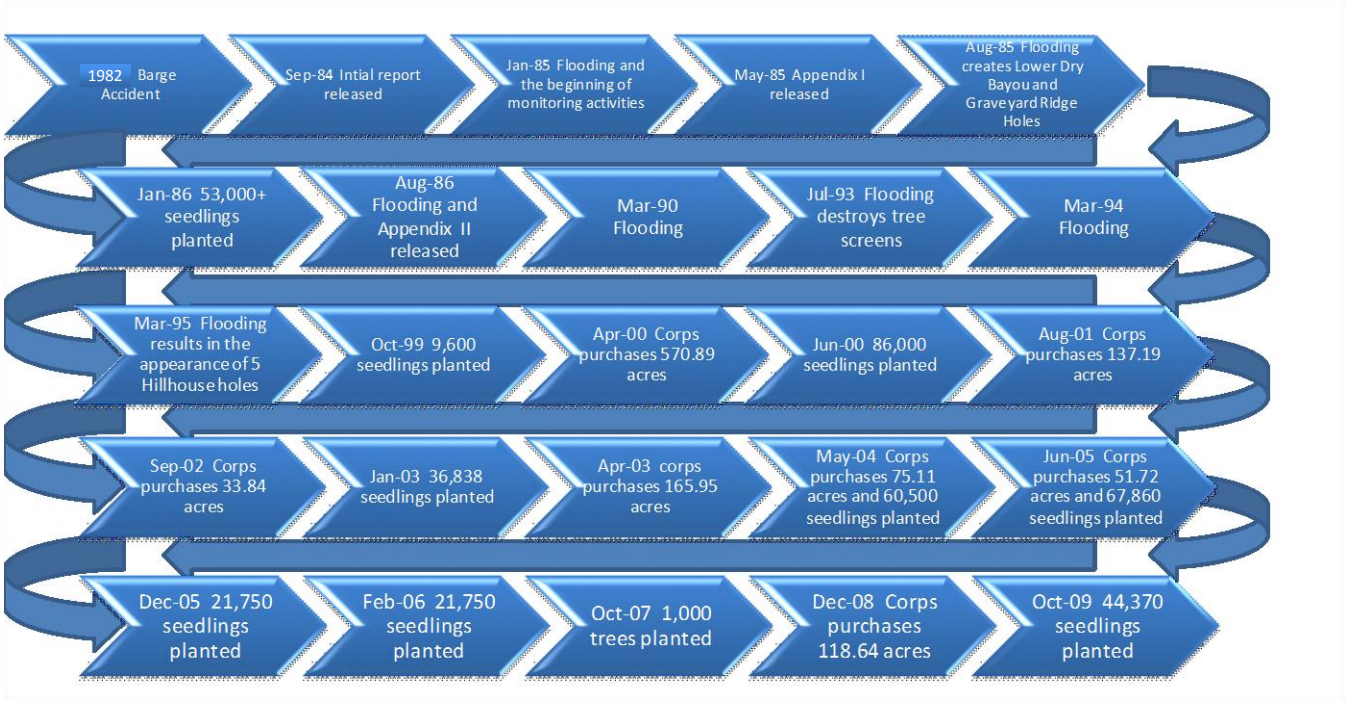

Figure 1: Project History

CONDITIONS PRIOR TO THE PROJECT

Throughout the years leading up to the beginning of this program, private interests performed significant clearing of natural vegetation for agricultural purposes. A historical investigation was conducted of the vegetation removal on the peninsula bounded by RM 22 to RM 5. The results are as follows:

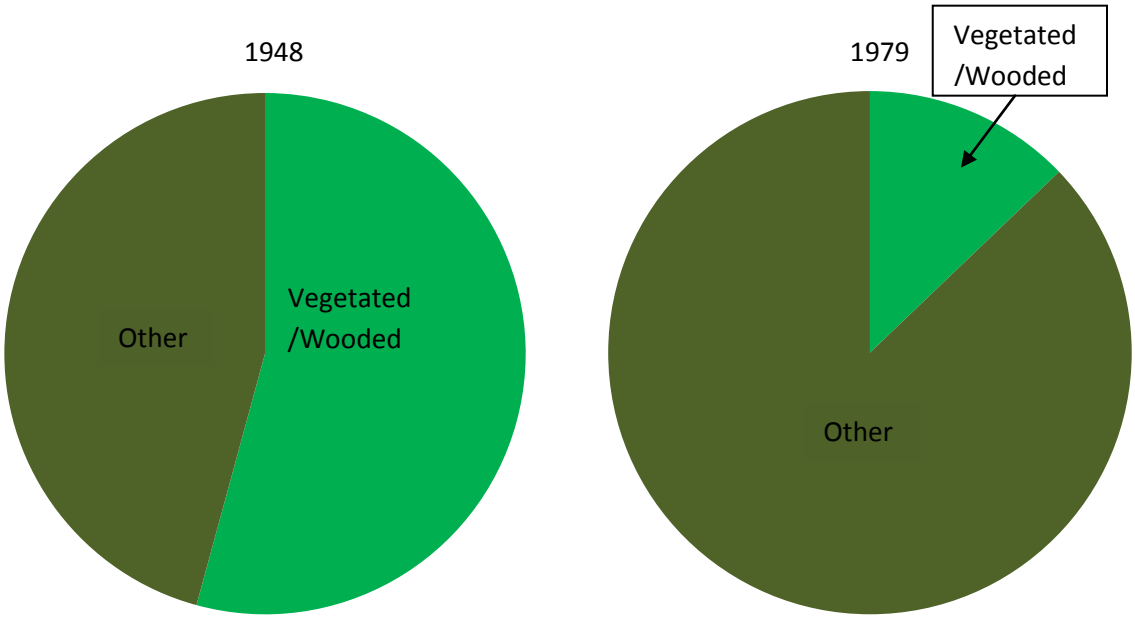

Figure 2: Change in Land Use

Total area contained on peninsula	10,825 Acres
Vegetated/Wooded Area in 1948	5,871 Acres
Vegetated/Wooded Area in 1979	1,391 Acres
Vegetated/Wooded Area removed between 1948 and 1979	4,480 Acres
1948 Vegetated/Wooded Area as a Percentage of Total Area	54.2%
1979 Vegetated/Wooded Area as a Percentage of Total Area	12.8%
Vegetated/Wooded Area Removed as a Percentage of Total Area	41.4%
Vegetated/Wooded Area Removed as a Percentage of 1948 Wooded/Vegetated Area	76.3%

As the data reveal, many substantial changes occurred in the area between 1948 and 1979. When the area experienced overbank flows, prior to these changes, there were many wooded areas to reduce the water's velocity and stabilize the topsoil. Following these changes, overbank flows traversed the width of the peninsula largely unobstructed.

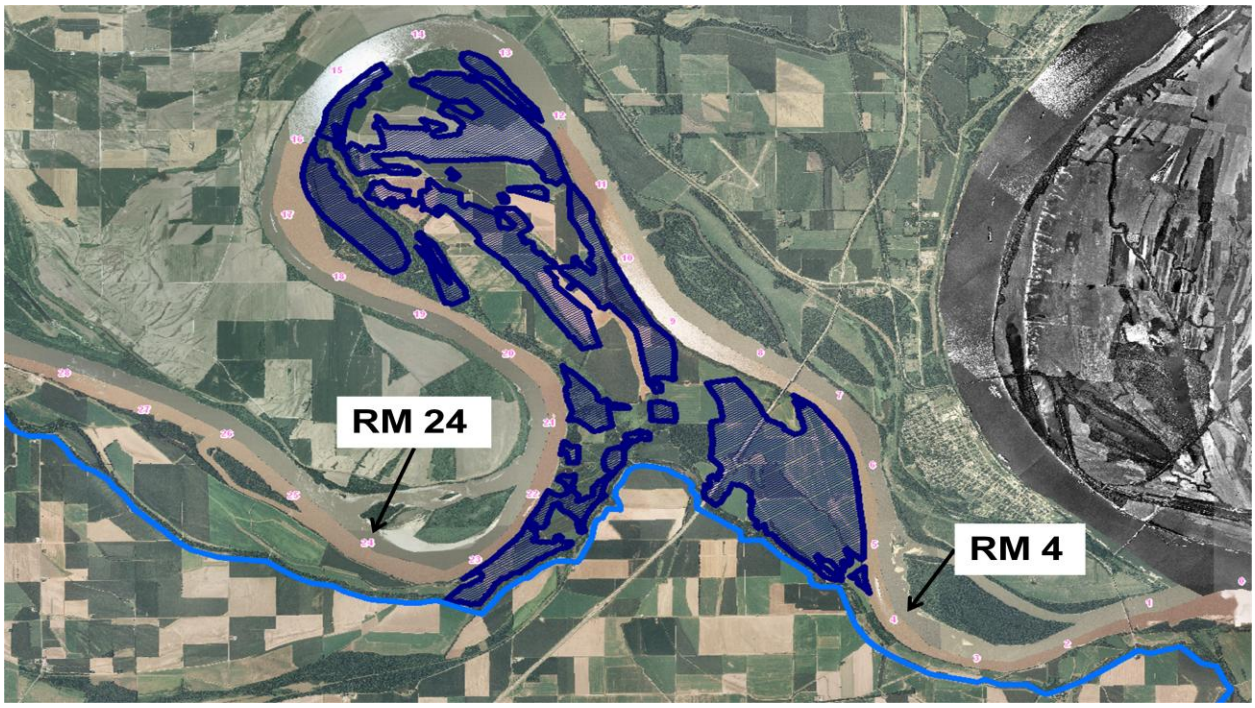

Figure 3: Project area showing the land that had been cleared from 1948 to 1979

Private levees extend on or near the top bank of the Mississippi River throughout the area. In addition to these, private levees have been constructed in the interior areas along property lines. These structures are earthen and vary in height depending on topography. They are subject to overtopping by flood flows, making them highly susceptible to crevassing.

Local interests constructed an earth-fill across the mouth of Dry Bayou about 350 feet from the Mississippi River in August 1969. The fill was approximately 400 feet in length and was constructed for the purpose of limiting the entry of Mississippi River flow into Dry Bayou.

A high water event occurred in 1982 while the study process for the initial report was ongoing. During this high water event, some barges broke loose from their tow. They went through the bank line and the private levees. Not only was damage done to the bank line and private levee, but the propeller wash from the recovery efforts also scoured interior farmland.

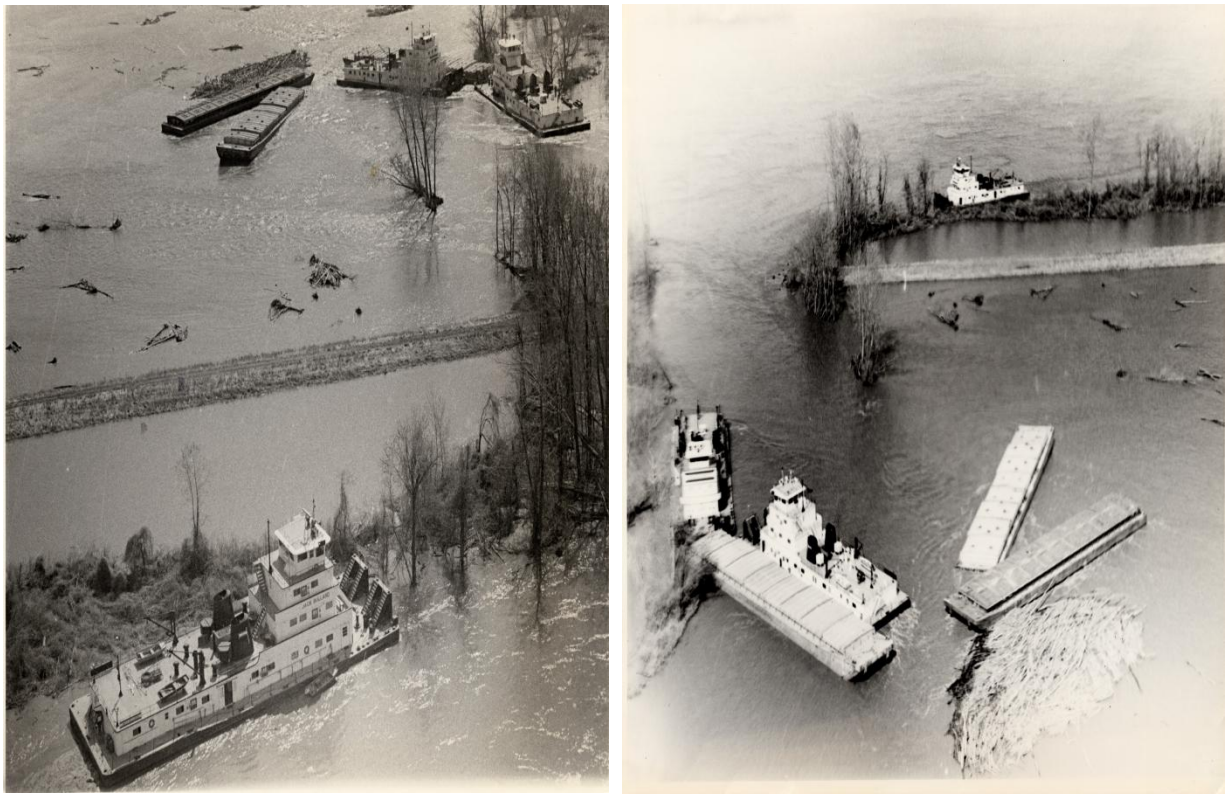

Figure 4: Recovery Efforts of Barge Accident in 1982

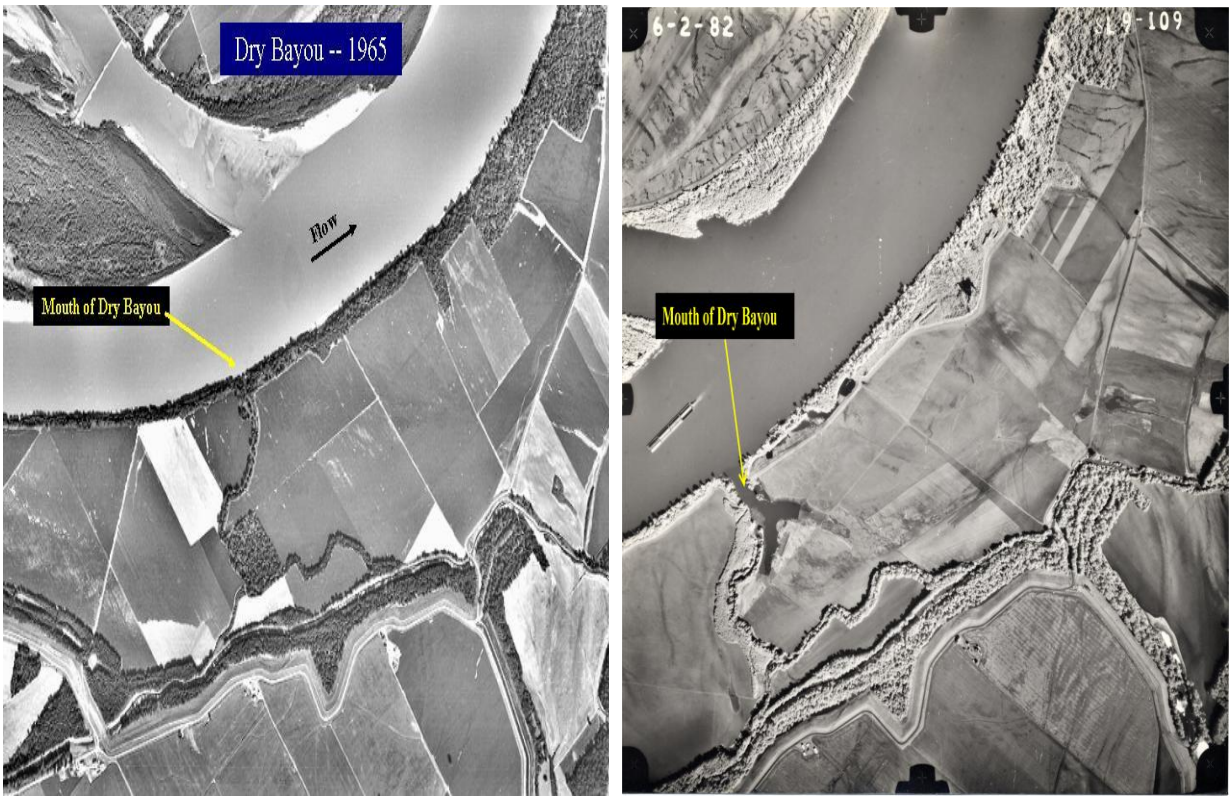

Figure 5: Mouth of Dry Bayou Before and After Barge Accident

INITIAL PROBLEMS IDENTIFIED

At the time of the initial report in 1984, several potential problem areas were discussed. These problems were 1) concentrated flows toward the Missouri bank causing increased scour, 2) the potential for a chute cutoff to form, 3) impacts caused by the swellhead from fill from the I-57 bridge approach, and 4) erosion of access roads to the Price Landing Area.

The first potential problem discussed was the thought that low water dikes concentrated flows on the Missouri bank, increasing the severity of flows against the western bank line which led directly to the occurrence of scour holes. At the time, initial indications were that this was not the case; however, further testing with a movable bed model was recommended to confirm these indications.

The second concern was the potential for a cutoff to form across the peninsula. The revetment of the bank line would likely prevent the occurrence of a neck cutoff occurring. The potential for a chute cutoff remained. This was because the initial erosion and scour was occurring landward in the bayou; however, the processes were not advanced enough to have created a channel. Further monitoring of the area was recommended.

A third concern was the potential for local scouring and increased flow velocities as a result of the swell head caused by the fill in the approach to the Interstate 57 (I-57) bridge. While the construction of I-57 was designed for an increase in water surface elevation of 0.4 ft during the project design flood, a review of historical records indicated that the difference between the Thompson Bend Gage and the Birds Point Gage had varied from 0.7 feet to 13.0 feet. Such water slopes present the potential for increased flow velocities and scour around irregularities in the overbank area.

A fourth area of concern was the construction of access roads to the Prices Landing area. The construction of the roads had induced scour adjacent to the roads. The recommendation at the time of the report was to lower the elevation of the roads outside of the levee safe zone to that of the surrounding ground or to establish natural vegetation to serve as a buffer to scour.

INITIAL RECOMMENDATIONS

The initial report was completed in September 1984. The initial report contained several recommended courses of action. These actions were model tests, design and construction work, and monitoring. In addition to these actions to be undertaken by the federal government, there were also recommendations for local interests actions. These actions were to reestablish natural vegetation at select sites, implement effective management for future clearing of natural vegetation, and the formulation and execution of a policy to require evaluation of levees and access roads and to manage the need for future construction of private levees and roadways.

At the time of the initial report, a movable bed model test was underway. The primary purpose of the model was to address navigation concerns and therefore was focused on within-bank flow considerations. The model tests were to include different dike configurations, underwater vanes, and additional bank line revetment.

Construction on the navigation channel in the project area was scheduled in phases. When the initial report was released, phase I construction was scheduled to begin in the following fiscal year (FY 85). That phase was to consist of dike and revetment construction below RM 19.6. The following phases were to be designed based on the evaluation of the model studies previously mentioned.

A monitoring program was to be established following the report. This program was to consist primarily of aerial photos and overbank monitoring. Aerial photography was already being taken yearly. The plan called for taking photos in this reach when overbank flows were at or near crest and again immediately after the flows had receded.

It was recommended that local interests begin the process of reestablishing the natural vegetation that had been removed over the years. This effort was intended to serve two purposes. The first purpose was to promote the natural healing of areas that had already experienced erosion. The second purpose was to minimize additional erosion in the area.

Another recommendation in the initial report was the effective management of future clearing of natural vegetation. It was recommended that, as a part of the reestablishment of natural vegetation, the local interests implement a plan to manage the future clearing of natural vegetation. The clearing management plan recommended the close monitoring and careful consideration of any additional clearings.

The final recommendation proposed several alternatives with regard to managing the construction of elevated structures, i.e. access roads and private levees. The first was the establishment of thick vegetation on either side of roads and private levees to slow flow velocities and minimize erosion. The second alternative was to include the design of a fuse plug section to allow for flow to continue through an easily eroded area of the structure. The third alternative was to orient access roads as possible parallel to the flow as they extend riverward so that they did not act as an obstruction to flow.

INITIAL EFFORTS AND FINDINGS

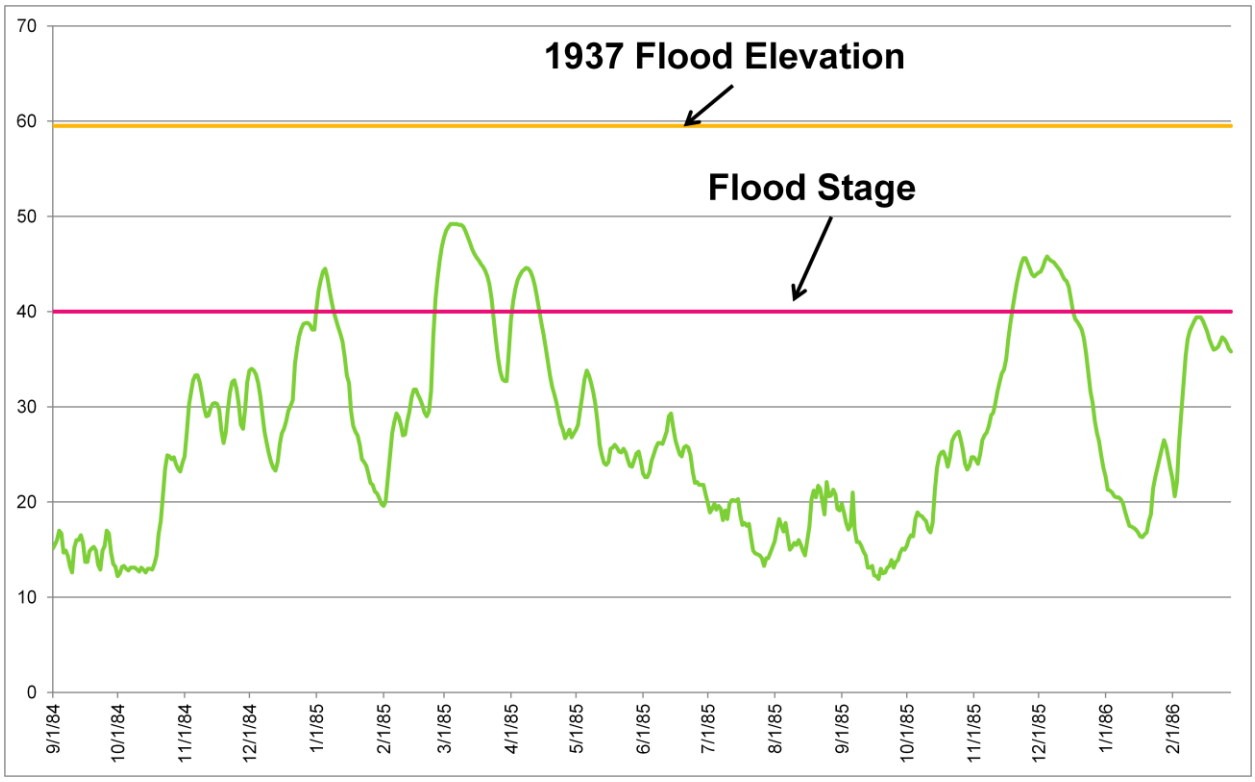

Figure 6: 1985 Water Surface Elevations

Upon completion of the initial report in September 1984, the plan was to begin the monitoring program in January 1985. Before the program could be initiated, the Upper Mississippi River Valley experienced heavy rains causing flooding in the project area in January 1985. The flooding prompted the beginning of the monitoring program through the taking of aerial photography. Access to the project site was limited because of the flooding so further measures could not be implemented. Record snowfalls occurred in the area after the flooding which further limited access and delayed the implementation of the program. Following the thaw, the Mississippi

experienced very high stages during most of the late winter and early spring months of March and April. Due to all of these delays the monitoring program was initiated over a period of five (5) months. Aerial photographs were taken in January, February, March, and April of 1985. Flow velocity measurements were taken in February and March of that same year. Swellheads were measured in February and April. Crest gage installation began in March and ended in May. Scour range surveys were completed in May.

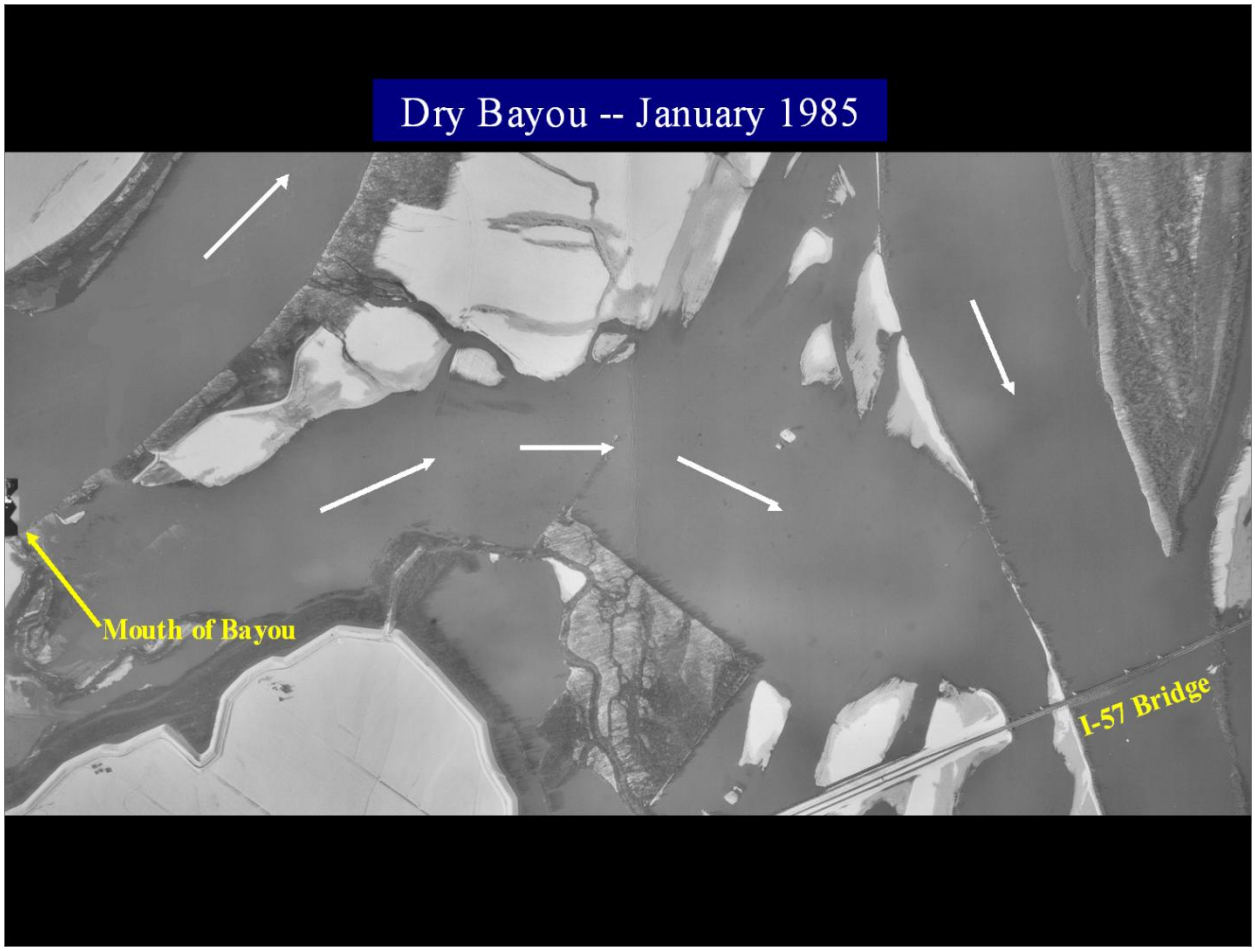

Figure 7: Aerial Photo of Thompson Bend-Dry Bayou During Flood (Jan 1985)

The aerial photographs taken in January 1985 show that, upon entering the bend, portions of the flow take separate paths. A portion of the flow passes through the I-57 relief opening. The other portion flows across the bend and reenters the river between miles 7.5 and 10.0. These ideas are reinforced by the photographs taken in February and March. Additional photos taken in March and April reveal the scour patterns downstream of the control structure and private levee breach, downstream of the access road into Thompson Bend, and in the vicinity of the I-57 relief opening.

Due to the inclement weather and other delays, installation of a gage to measure water crest elevation could not be completed until May 1985. Because of this, the swellhead measurements were accomplished by standard survey techniques. Swellheads ranged from 1.94 feet to 2.62 feet on the west side of the I-57 relief opening. Swellheads on the east side of the relief opening were measured between 1.56 feet and 1.75 feet. Swellheads were also measured on the Missouri side of the Mississippi river opening and ranged from 0.45 feet to 1.31 feet.

Velocity and flow measurements were accomplished on four (4) different days in March 1985. Velocities were measured at the I-57 Bridge, I-57 relief opening, control structure, and private levee breach. Velocities

measured at the bridge were approximately 9.3 feet per second (fps). Velocities taken at the relieve opening were in the range of 3.8 to 6.4 fps. Velocities at the control structure and the levee breach were in the range of 5 to 8 fps.

FOLLOW UP RECOMMENDATIONS

A list of recommendations made after the round of events occurring in late 1984 and early 1985 was included in the Appendix published in May 1985. These recommendations were not significantly different than those presented in the September 1984 report. These included continued monitoring of the area with emphasis on aerial photography, surveys, and swellhead measurements, regular communication between local interests and the U.S. Army Corps of Engineers, continuation of the reestablishment of natural vegetation by local interests, and the use of information collected for the appendix as a baseline for the future.

SECONDARY EFFORTS AND FINDINGS

Prior to the high water events of late fall of 1985, the local interests had begun planting the tree screens as recommended in Appendix I. Local interests had also successfully established natural vegetation on the landward side of the Dry Bayou Control Structure blue-hole. They constructed a concrete apron on the immediate downstream side of the access road to prevent any serious damage to the road or scour on the downstream side of the road. The local interests also implemented two other protective measures by planting winter wheat or leaving Milo stubble in the fields after the harvest.

The high water events in the fall provided an additional opportunity for the monitoring plan to be tested. During this period, the Mississippi River exceeded flood stage during the final weeks of November and for a second time in the middle of December. During and following the high flow events, the monitoring program consisted of aerial photography, swellhead measurements, still photography, and surveys of the scour ranges.

Review of the information collected during the monitoring indicated that new damages had occurred during the flooding. The damages consisted of significant amounts of surface scour immediately landward of the private levee repair, degradation of the stone repair at the private levee, additional damage to the blue-hole at Graveyard ridge, development of a new blue-hole landward of Thompson Gage, and scour of the right bank of Big Lake Bayou. All of these items and the measurements were reported in Appendix II of the report dated February 1986.

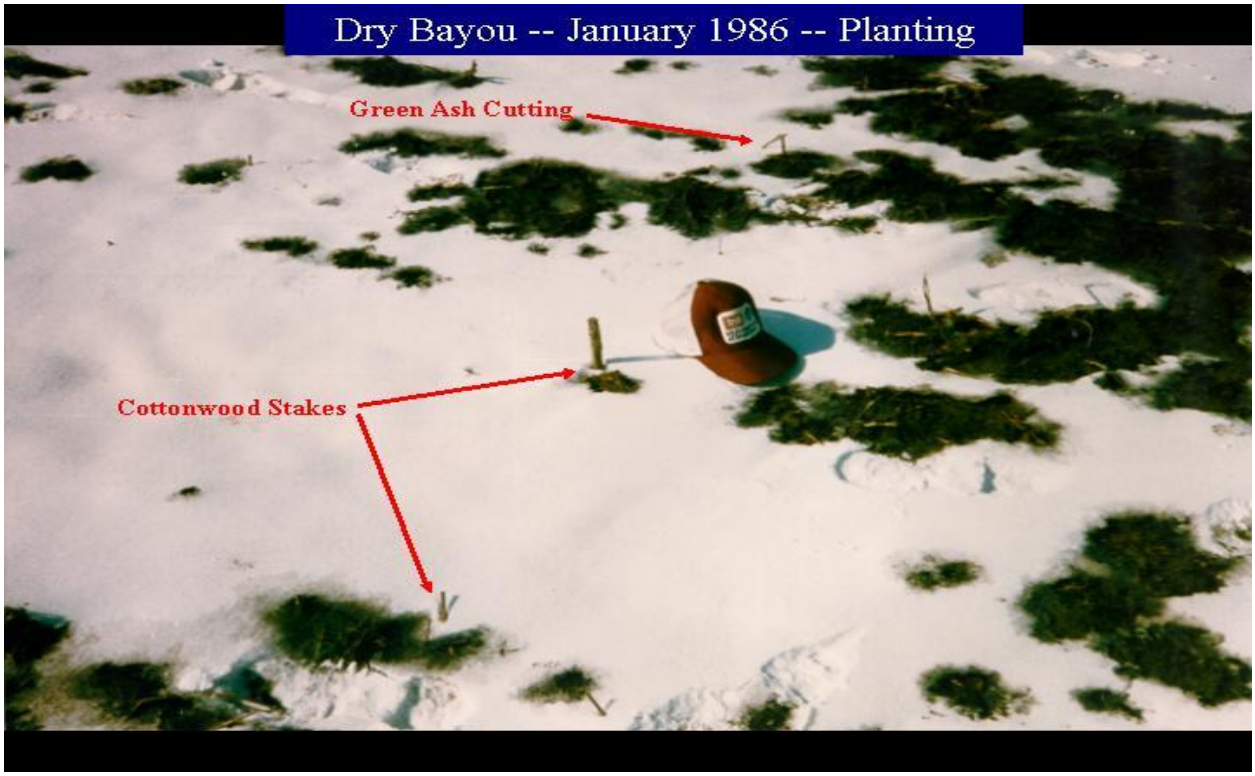

Figure 8: Photo of Some Tree Plantings in Dry Bayou-Thompson Bend

After the high water receded, the local interests undertook efforts to establish tree screens. During the period of January and March 1986, local interests, in cooperation with various agencies, planted more than 53,000 tree cuttings in the bend. In addition to these improvements, stone repair was also done to the private levee breach and the bank line at Graveyard Ridge was repaired.

EVENTS AFTER 1986

The project area was subject to floods in the fall of 1986, spring of 1990, the spring of 1994, and the spring of 1995. Each of these events occurred over various durations with various flood stages but the greatest test of all was the Great Flood of 1993.

The flood of 1986 occurred when the new tree plantings were only in the ground for less than a year. The trees averaged between two and three feet tall. The majority of the drift from this event was caught by the vegetation behind the scour holes. Post flood inspections and surveys revealed very minor erosion and approximately 75% of the tree plantings had survived.

The flood of 1990 was very similar to the flood of 1986 but very little of the flood drift found its way into the bend and the erosion and damage to the project area was minimal. The trees had grown to an average height of 25 to 30 feet. The erosion and damage to the project area after the flood was minimal.

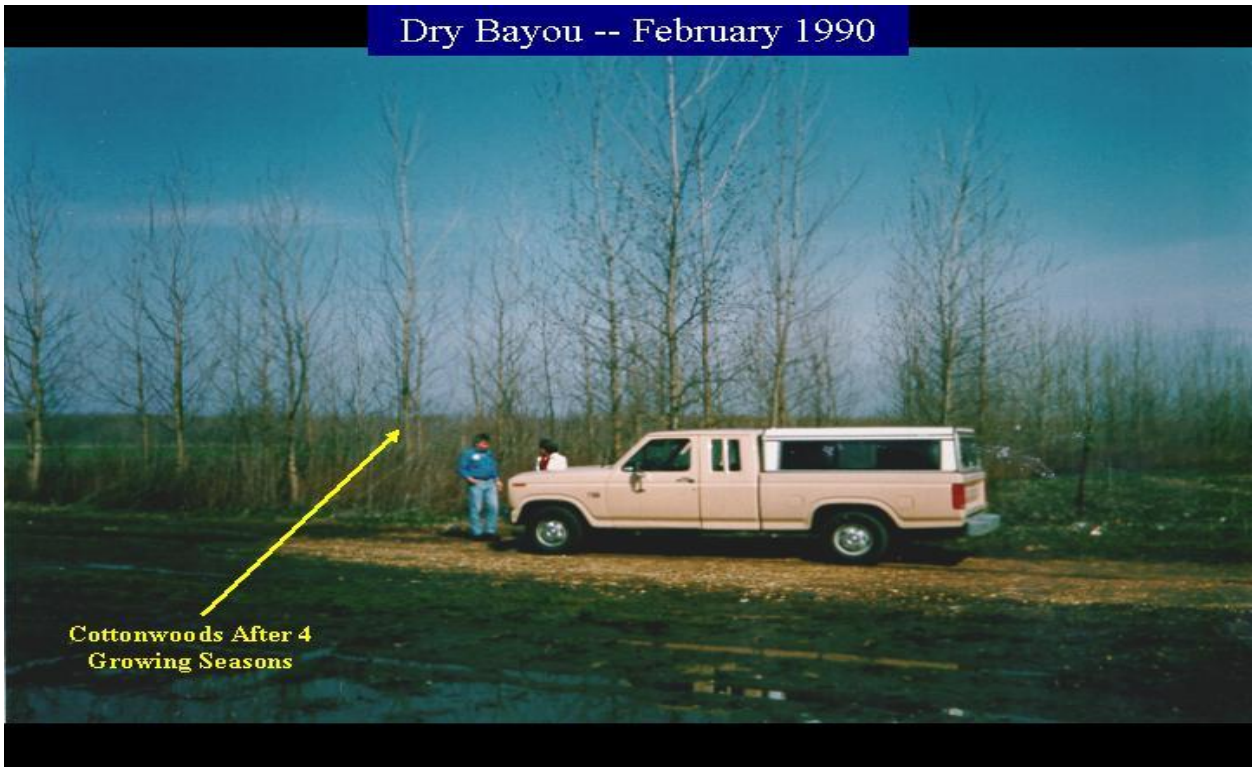

Figure 9: Tree Growth in Dry Bayou

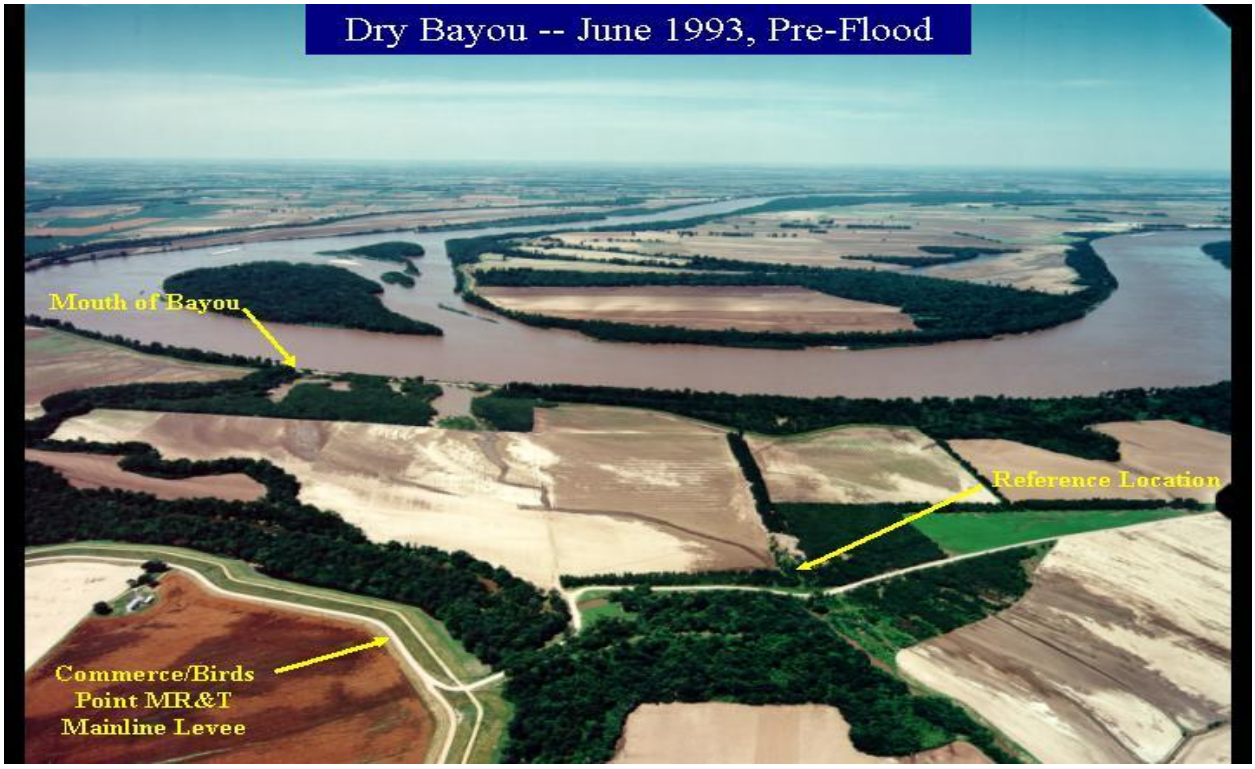

Figure 10: Dry Bayou Prior to the Great Flood of 1993

The flood of 1993 was a far greater test for the project area as the flood caused 130 days of overland flow in the bend. At times, flow velocities were in excess of 10 feet per second, partially due to a lower flow on the Ohio River. Although vegetation that was inundated with flood flows for the four month period did not survive the event, it did protect the land from severe scour. And while most vegetation was destroyed, no crops were produced, and some damage was done to the bank line, the project fared better than expected.

Figure 11: Hillhouse Break 1 During 1993 Flood

Figure 12: Hillhouse Break 2 During 1993 Flood

Figure 13: Hillhouse Break 3 During 1993 Flood

Figure 14: Hillhouse Break 4 During 1993 Flood

Figure 15: Private Levee Breach at Original Dry Bayou During 1993 Flood

Figure 16: Lower Dry Bayou During 1993 Flood

Figure 17: Access Road During 1993 Flood

Figure 18: Thompson Bend Throat During 1993 Flood

Figure 19: Graveyard Ridge During 1993 Flood

Figure 20: I-57 Relief Opening During 1993 Flood

Figure 21: I-57 Bridge During 1993 Flood

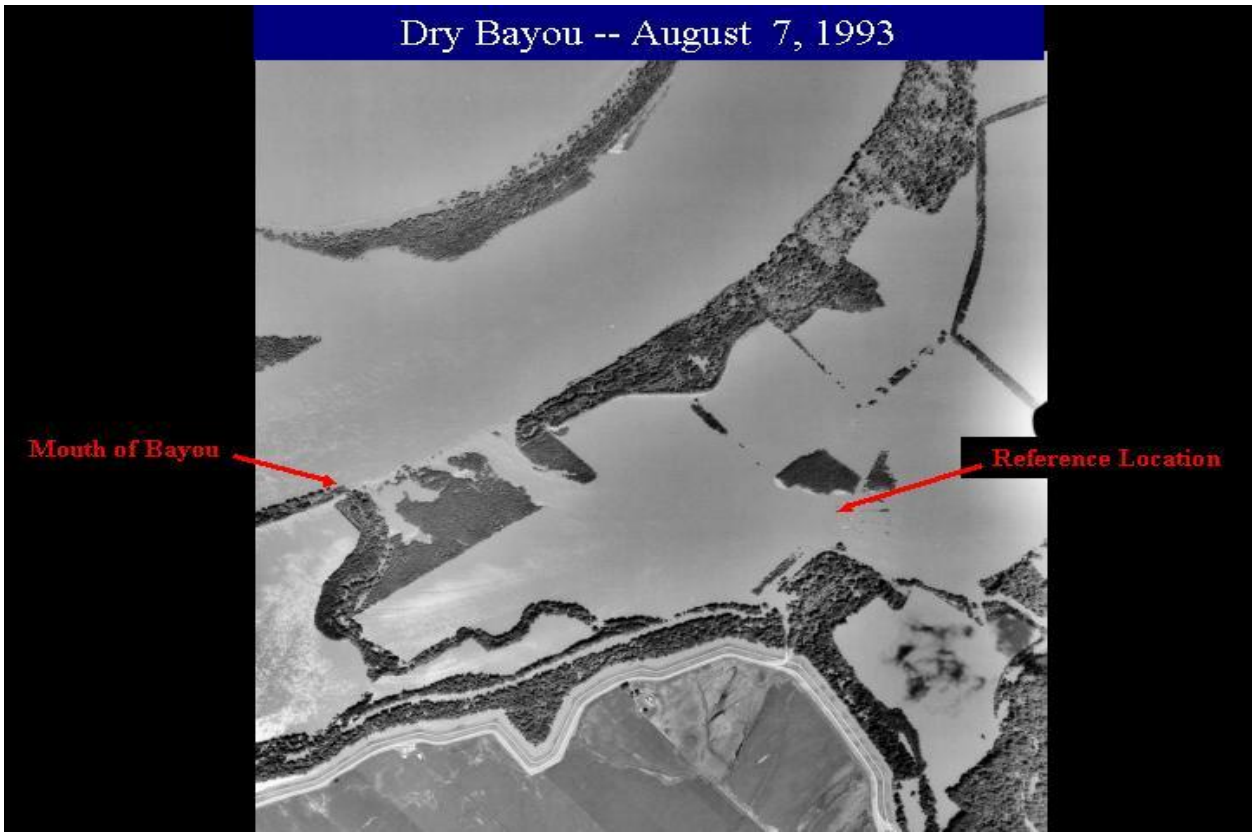

Figure 22: Dry Bayou During the Great Flood of 1993

Figure 23: 1993 Flood Damage

The flood of 1994 was a relatively minor event caused by high flows on the Ohio River. This caused a backwater effect, but the velocities were minimal and very little erosion occurred. The major consequence from this flood was that the event did not allow time for the vegetation to re-establish itself after the 1993 damage.

The flood of 1995 was the first since 1986 to cause obvious damage to the project area. Post flood analysis, Figure 24, shows a flow path across the bend, erosion, surface scour, as well as the damage done to the vegetation from three consecutive years of flooding.

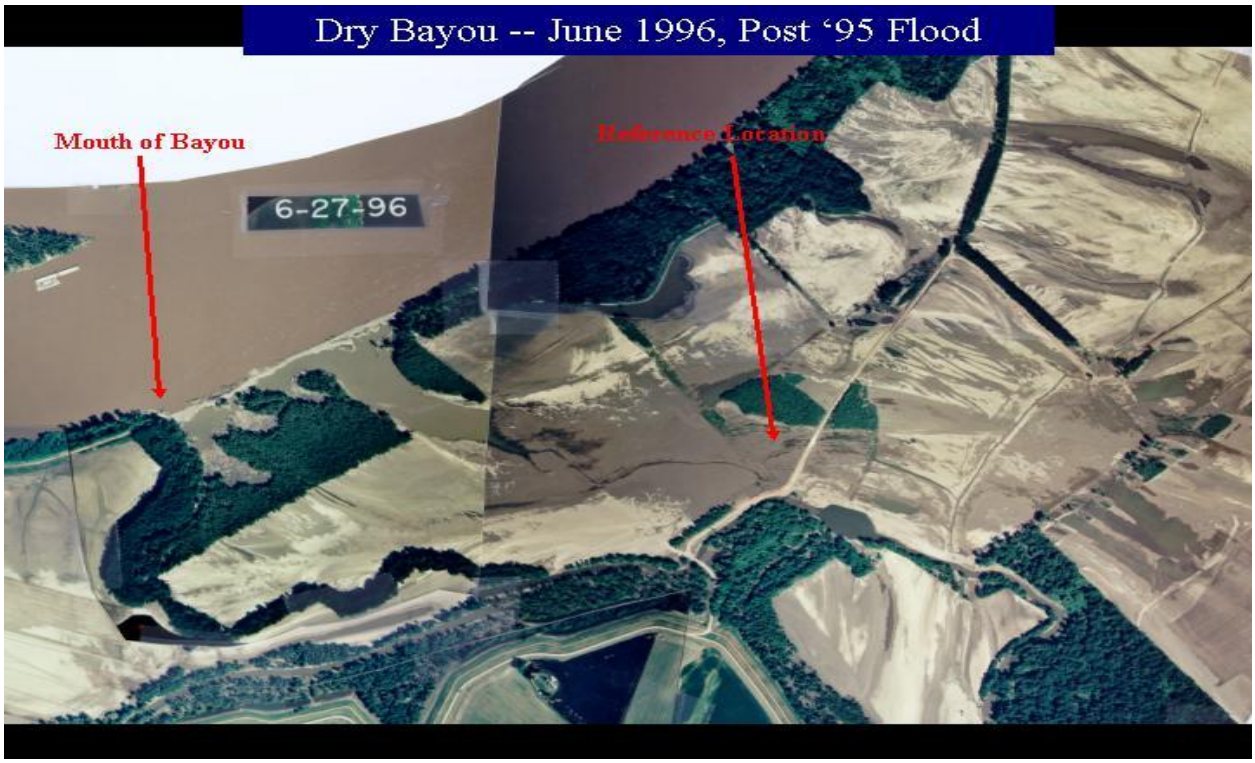

Figure 24: Dry Bayou After the 1995 Flood

EFFORTS AFTER FLOODS OF MID-1990s

After the floods of the 1990s it became clear that the planting efforts undertaken by local entities were not sufficient to address the issues facing the project area. The St. Louis district again partnered with the landowners to plan and implement a vegetation control plan. The Corps of Engineers began purchasing permanent, restrictive easements from the land owners. See Plate 2. Since 2000 the Corps has purchased more than 1153 acres in easements, implemented easement management plans, and has designed and constructed additional revetment and other rock features in the project area. See Figures 25 -31. The Corps has also planted more than 274,000 trees and other vegetation on more than 600 acres of easements in the project area to reduce erosion caused by overland flows. The remaining acreage is either reserved for access and roads, labeled "Road Easements" in Plate 2, or already had forests existing which just needed to be maintained and managed. The specifics of these tree plantings are presented in Table 1.

Figure 25: Dry Bayou Revetment February 1998 (demonstrating effective tree screen reducing scour)

Figure 26: Tree Screens and Baffles at Upper and Lower Dry Bayou Scour Holes in 2000

Figure 27:Tree Screens and Baffles at Upper and Lower Dry Bayou Scour Holes in 2000

Figure 28: Tree Screens and Baffles at Upper and Lower Dry Bayou Scour Holes in 2000

Figure 29: Hillhouse Break Area in 2000

Figure 30: Hillhouse Break Area in 2000

Figure 31: Access Road Tree Screen in 2000

Table 1: USACE Tree Planting (See Plate 2 for map locations)

Date	Description	# Trees	Type	Tree Species	Acres	Spacing	Planter	Comments
Oct-99	Lower Dry Bayou	9,600	Seedling	Cottonwood	22	10x10	Levee District #3	
Jun-00	Hillhouse (40), Mark Rowling (20), Norbert Rowling (10), Drinkwater (50), Sunburst (30)	65,250	Seedling	55,250 Cottonwood, 10,000 Green Ash	150	10x10	Levee District #3	Preplant herbicide treatment applied
Jun-00	Adkinson Tract	20,750	Seedling	Cottonwood	50	10x10	Levee District #3	Preplant herbicide treatment applied
Jan-03	Dry Bayou, Drinkwater	36,838	Seedling	18419 Cottonwood, 9210 Green Ash, 9209 Sycamore	84.68	10x10	General Property Maintenance	
May-04	Drinkwater (48), Graveyard Ridge (6), Adkinson (50), Sunburst (10)	60,500	Seedling	11500 Cottonwood, 24500 Green Ash, 24500 Sycamore	114	10x10	General Property Maintenance	Had to do some pre-plant mowing and herbicide application to remove weeds.
Jun-05	Replant Drinkwater (25), Drinkwater (55), Replant Misc Graveyard Ridge, Adkinson and Hillhouse	67,860	Seedling	22620 Cottonwood, 22620 Green Ash, 22620 Sycamore	156	10x10	General Property Maintenance	Had to do some pre-plant mowing and herbicide application to remove weeds.
Dec-05	Hillhouse (5), Mark Rowling (10), Sunburst long leg (25), Mark Brown (10)	21,750	Seedling	Cottonwood	50	10x10	Midwest Seedling Supply	
Feb-06	Replant Drinkwater fields and Sunburst long-narrow area	21,750	Seedling	Cottonwood	50	10x10	Midwest Seedling Supply	
Oct-07	Scattered plantings along Graveyard Ridge and Sunburst in low depressional areas	1,000	Root Production Method	Cypress and pin oak	20	Min 30 feet from each other	Midwest Seedling Supply	
Mar-08	Kirkpatrick and Sunburst 2007 harvest area, Sunburst supplemental plantings	20,000	Seedling	5000 each Pin Oak, Willow Oak, Overcup Oak and Swamp Dogwood	46	10x10	Midwest Seedling Supply	
Oct-09	Westrich	44,370	Seedling	22185 Cottonwood, 22185 Sycamore	102	10x10	Quality Forest Management	Established grass cover crop of redtop and Virginia wild rye - preplanting
	TOTAL:	**274,068**			**622.68**			

The Corps has also facilitated regular maintenance in the form of spraying outrider, a selective herbicide, mowing, herbicide treatment, and some timber harvest to reduce eddy scouring. A selective Timber Harvesting Plan has also been created and implemented as part of the Thompson Bend Riparian Corridor Project

Management Plan. The timber harvesting places focus on removing portions of mature-forested areas to allow sunlight penetration to facilitate undergrowth. The Corps continues to monitor the project area with regular aerial photography and intermittent land surveys and water velocity measurements.

2011 FLOOD

The spring of 2011 brought another extreme test for the project area. During this flood event, water levels exceeded those of the 1937 flood and lasted more than 60 days. See Figure 32.

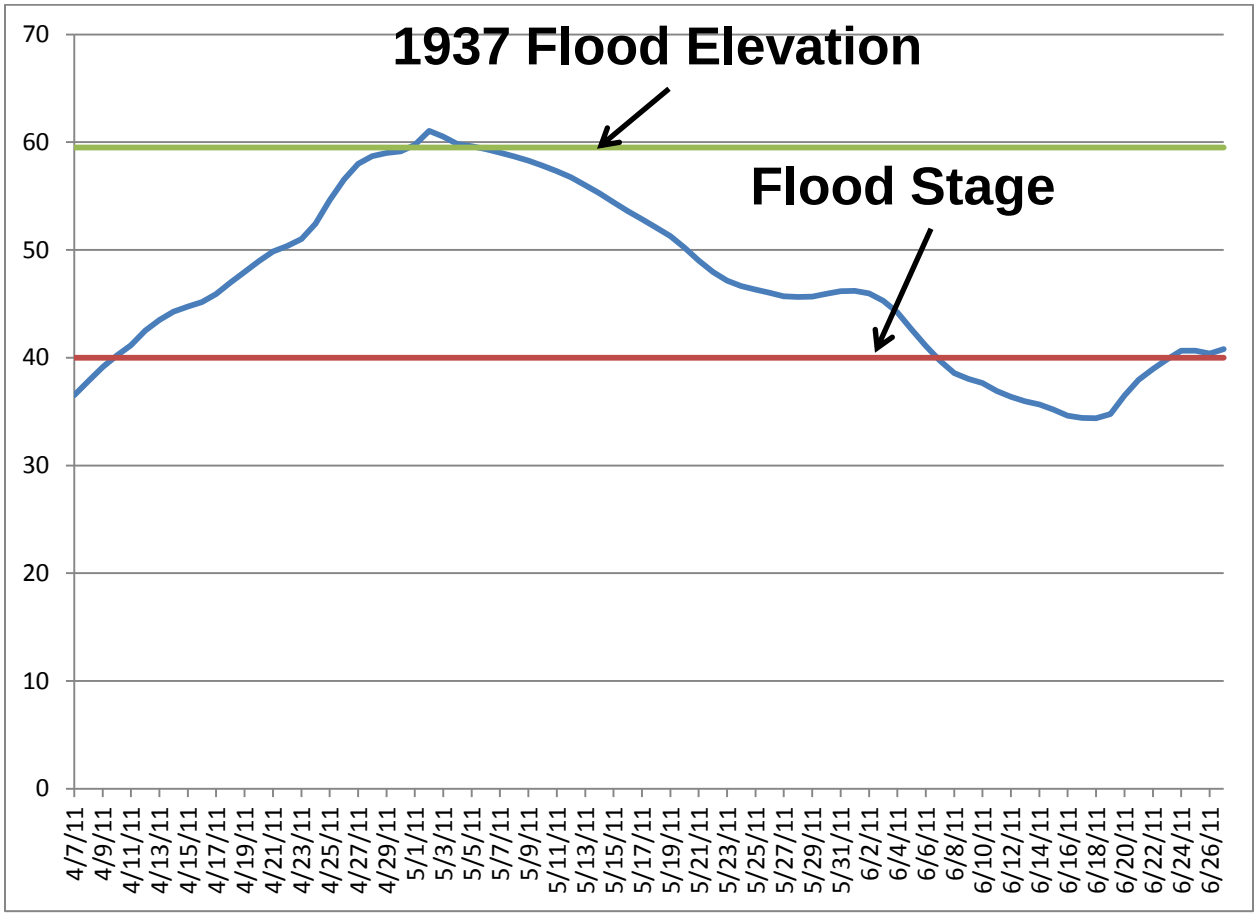

Figure 32: 2011 Water Surface Elevations

During the flood, flow velocity measurements were in the 2 fps or less range; well below the velocities required to cause concern about scour. The pictures below show the same basic location at the entrance to Dry Bayou. The picture on the left of Figure 33 shows the water pouring in to the project area with a lot of energy and high velocities. The picture on the right of Figure 33 shows the project area after the addition of tree screens. The water appears calm and a debris plug has developed due to tree screens catching the debris and holding it in place.

Figure 33: Entrance to Dry Bayou

A second follow-up site visit was made after the waters receded. The land had been dry for three or four weeks and the damages to the project area appeared minimal. The vegetation appeared green and vibrant. See Figure 34.

Figure 34: Vegetation after 2011 Flood

There were some damages noted after the flood event. Some additional scour was noted in low lying areas of the peninsula and there was some erosion on the bank line between RM 10 and RM 9. See Figure 35 and 36.

Figure 35: Scour in Low Lying Area of Peninsula after 2011 Flood

Figure 36: Bank Erosion between RM 10 and RM 9 after 2011 Flood

FUTURE PLANS

The Corps understands the importance of this project area and continues to observe the events that may occur in this reach of the river. The Corps's future plans include continued monitoring on a consistent basis. Monitoring will become even more of a priority during and after future flood events. Additionally, the Corps will continue to correspond and meet with landowners as needed. The planting and replanting of vegetation shall continue as needed. The Corps also intends to continue with efforts in selective timber harvesting with emphasis on mature areas and controlled spraying to control unwanted grasses and weeds as necessary. Finally, the Corps will continue to maintain top bank control along the length of the project with revetments and other regulating works.